Oceanic Weather Product Development

Tenny Lindholm

Representing the FAA's Oceanic Weather Product Development Team

NCAR

Federal Aviation Administration (FAA) Aviation Weather Research Program

- Oceanic Weather Product Development Team (OWPDT)

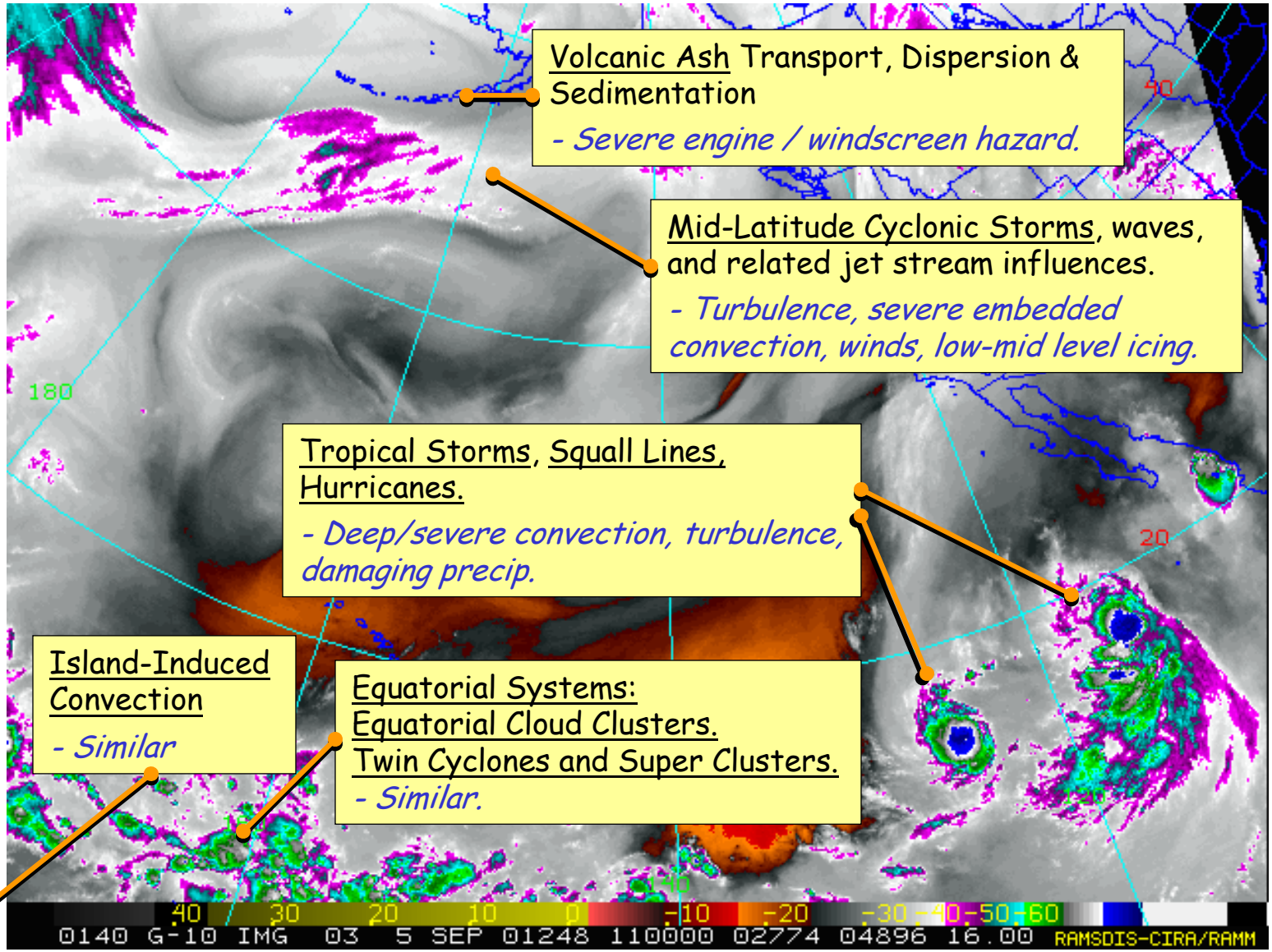
Oceanic Weather Team

- Membership reflects strong scientific and user involvement to accomplish objectives
  - NCAR
  - NRL
  - MITLL
  - AWC
  - FSL
  - Cooperative Institute for Meteorological Satellite Studies (UW)—collaboration with NCAR, NASA, and NRL
  - Airlines—dispatch, flight operations
  - Air traffic management and control
  - CWSU
  - ARINC
  - NCEP
  - Oceanic IPT
  - NASA—Advanced Satellite Aviation Weather Products (ASAP) program, NASA Langley HF, AvSSP

FAA MNS #339, Aviation Weather

- Oceanic decision makers—pilots (all types), dispatchers, oceanic traffic managers and controllers
- FAA goals—enhance ***safety and efficiency***
- MNS approach and AWRP OWPDT direction—diagnoses, nowcasts, forecasts of
  - Convection
  - Non-convective turbulence
  - In-flight icing
  - Volcanic ash cloud dispersion
  - Winds aloft
  - Obstructions to visibility

Phenomenology – Oceanic Weather



Objectives

- Applied research and development toward informational weather products for (global) oceanic and remote regions. Initial focus based on formal user needs:
  - Convection
  - Turbulence, clear air (CAT) and convective induced (CIT)
  - In-flight icing (ETOPS)
  - Volcanic ash, detection and dispersion
  - Improved flight level winds
  - Obstructions to visibility (off-shore operations)
- Dissemination to end-users
  - Evaluation
  - Verification
  - Technology transfer to in-place or emerging infrastructure

Data Available

- Automated aircraft to ground weather reports—temperature, winds, relative humidity, turbulence. CRITICAL!
- Other data sources
  - Satellite—also critical
  - Global model output
  - Ship/buoy meteorological data
  - PIREPs
  - Global sounding data
  - Coastal/island weather radar
  - Sea surface temperature
  - LF/VLF/ELF lightning data

Approach to Oceanic Weather

- Improve shared situational awareness for pilots, controllers/traffic managers, and dispatchers
  - Extensive user interaction and input
- “Intelligent weather systems”
  - Use of expert system framework to mimic what a meteorologist does to generate a forecast
  - Allows fast and precise assimilation of all data that can add skill to generate *informational* products
  - Result: rapidly and frequently updated, high resolution, 4-dimensional graphic of the weather hazard that is easily transmitted to ground and airborne users

Notable Accomplishments

- First-ever data link of graphical oceanic weather to an airborne aircraft
  - United Airlines “campaign”
- OW Web site with full Pacific and GOMEX regions
- Cloud top height product, documented high-value from numerous end users—pilots, CWSU, ATC
- High level of PDT leveraging and liaison with user community
  - Airlines—United, Delta, American, Northwest, Continental
  - Pilot unions—ALPA, APA
  - Dispatchers—Airline Dispatcher Federation
  - Air traffic control and management—Oakland Center
  - Oceanic control center modernization programs—ATOP
  - Weather information providers and vendors

Notable Accomplishments

- Data ingest and archive system
- Hazard climatology
- Semi-annual scientific workshops (4 so far)
- Prototype global turbulence forecasting system (based on ITFA)
- Tropical Rainfall Measuring Mission (TRMM) satellite data analyses to contrast internal structure of oceanic deep convection with continental convection
- Intercomparison between oceanic convection diagnostics
- Enhanced flight level wind modules for oceanic regions

Product Status and Schedule (Operational)

- Cloud top height—2007
  - Prototype now
- Convective diagnosis (expert system)—2008
  - Prototype 2004
- Improved 3-D wind field—2005
- Convective nowcast (0-2 hours)—2009
- Turbulence (convective induced, clear air)—2010
  - Prototype CAT expert system—2003
- Volcanic ash dispersion—2010
- Convective forecast (2-6 hours)—2012
- In-flight icing—2012

Example Early Convective and Turbulence Products

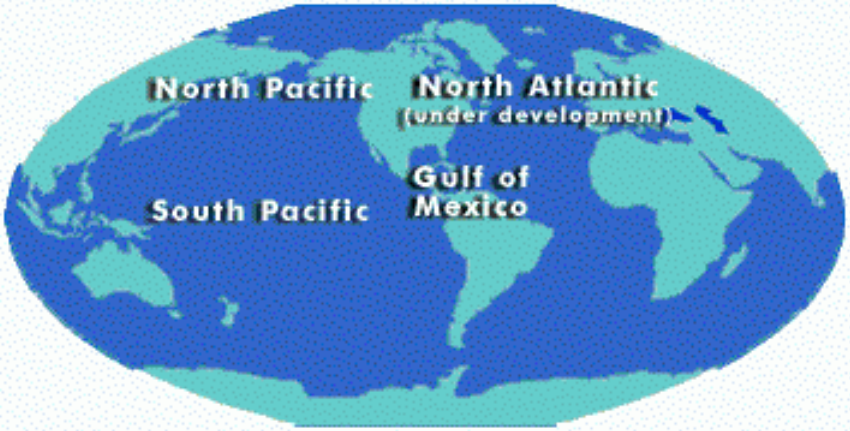
Oceanic Weather

MIT LL | ARINC | NRL | AWC | RAP

Research Applications Program

Oceanic Weather
PRODUCT DEVELOPMENT TEAM

The Oceanic Weather Product Development Team (OWPDT) is addressing oceanic weather needs for aviation along two dimensions – informational weather product development, and dissemination to end users. First, we are developing intelligent weather systems that generate timely information on convective weather (0–6 hour forecasts), convective–induced and clear–air turbulence, high–resolution winds, volcanic ash, and in–flight icing (for extended twin operations, ETOPS, decision support). Second, we are addressing quick product generation, and methods for timely dissemination to air traffic controllers, dispatchers, and airborne flight crews. The OWPDT is sponsored by the **FAA's Aviation Weather Research Program**.



Project Description
Go here to view major areas of research and aviation weather hazards for oceanic/remote areas. Development status can also be found here.

Development Team
Go here to view core team members and their roles.

Working Documents
Here you will find plans, technical papers and presentations, and other materials shared with our sponsors and the research community.

Realtime Prototype Systems
Go to your desired region to view currently available oceanic/remote weather products.

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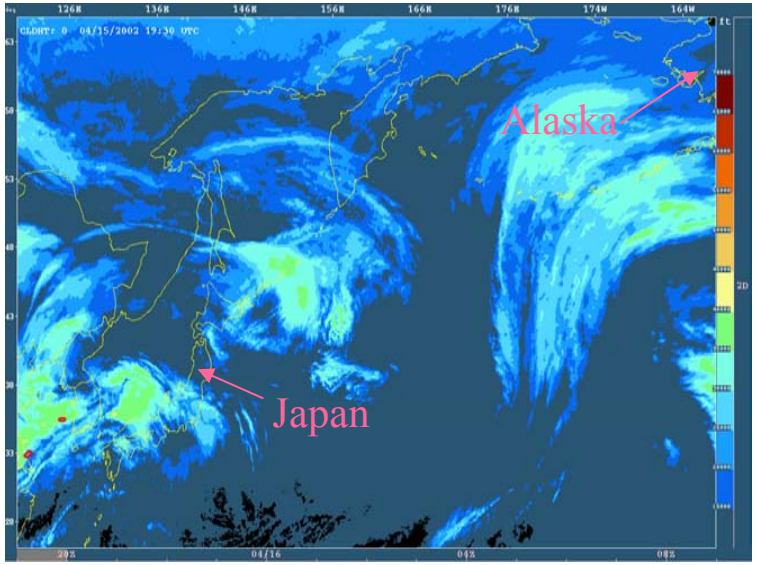
Updated 02/22/2002

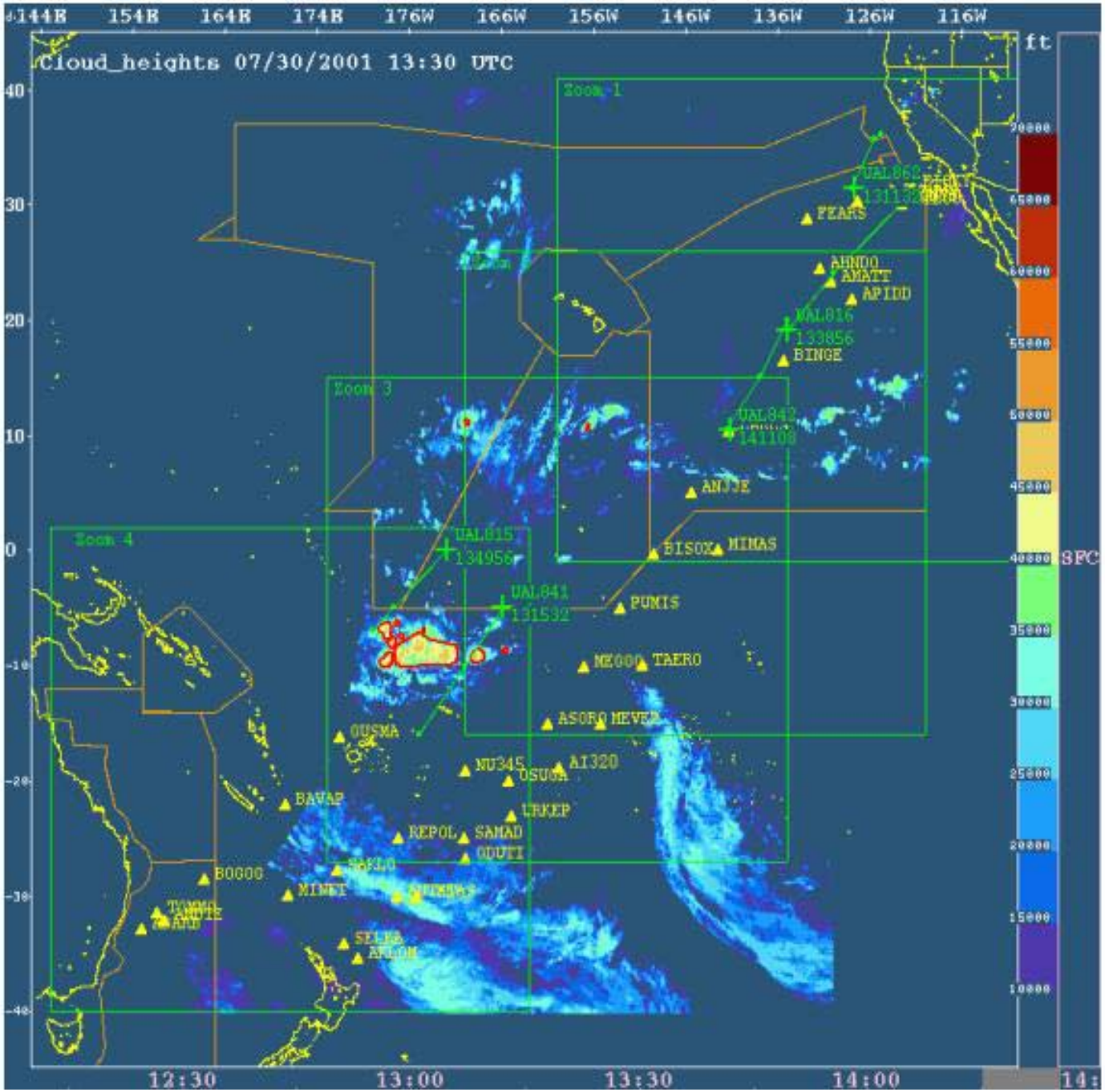
Oceanic Weather Regions

- Pacific
- Gulf of Mexico
- North Pacific
- North Atlantic (exact region not defined)



Thunderstorm Nowcasting Domain Size

NCWF Domain Size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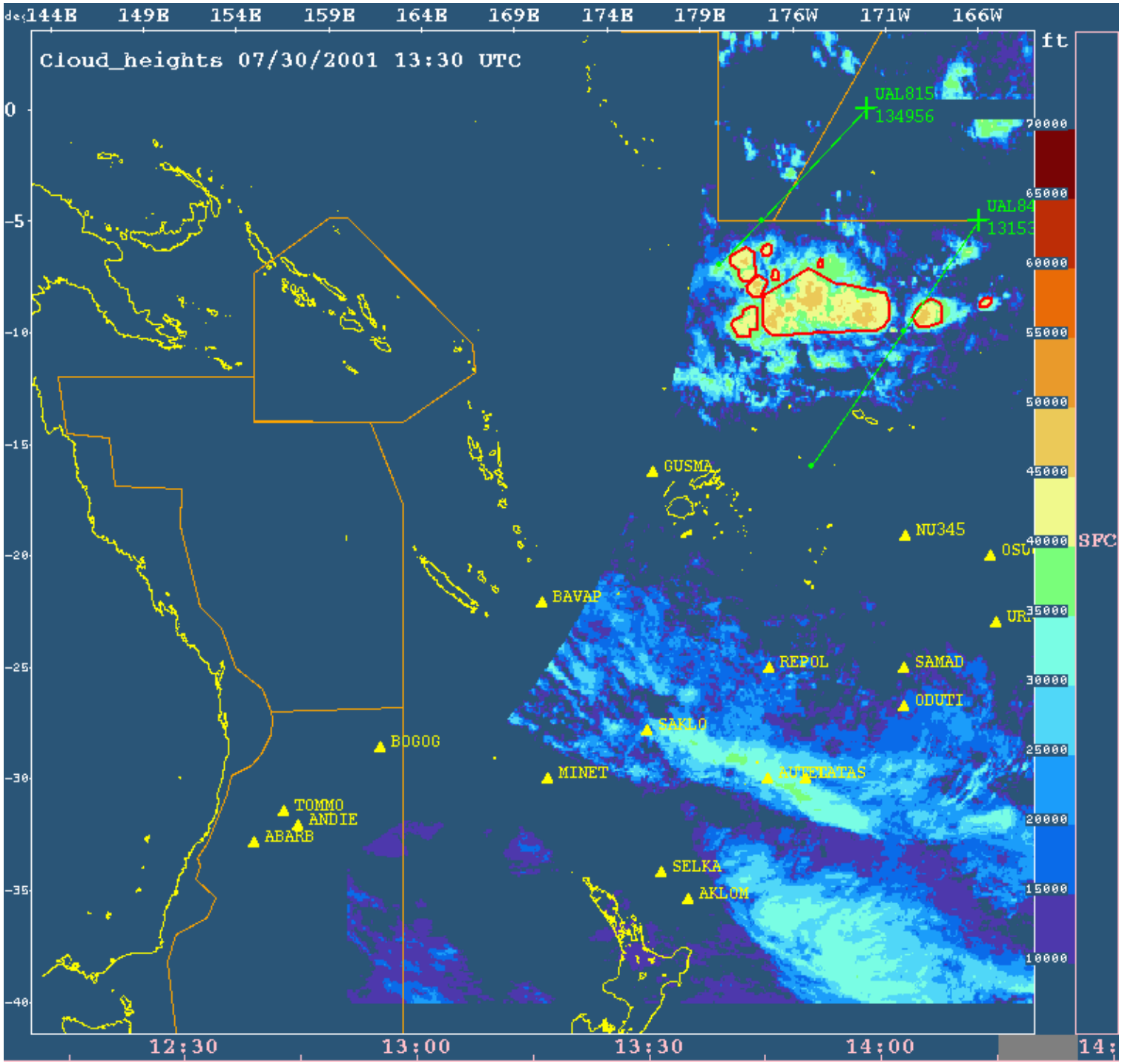
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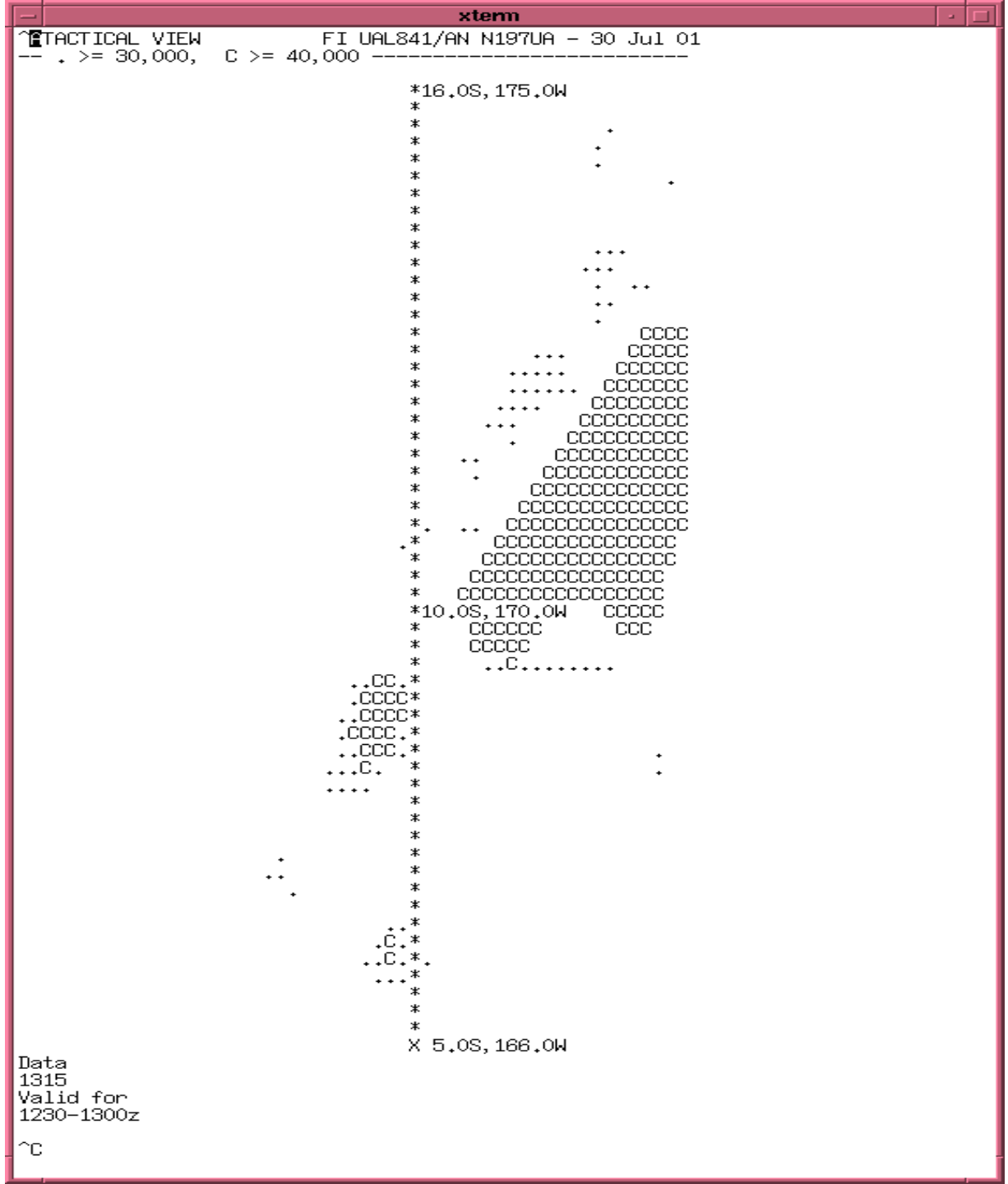
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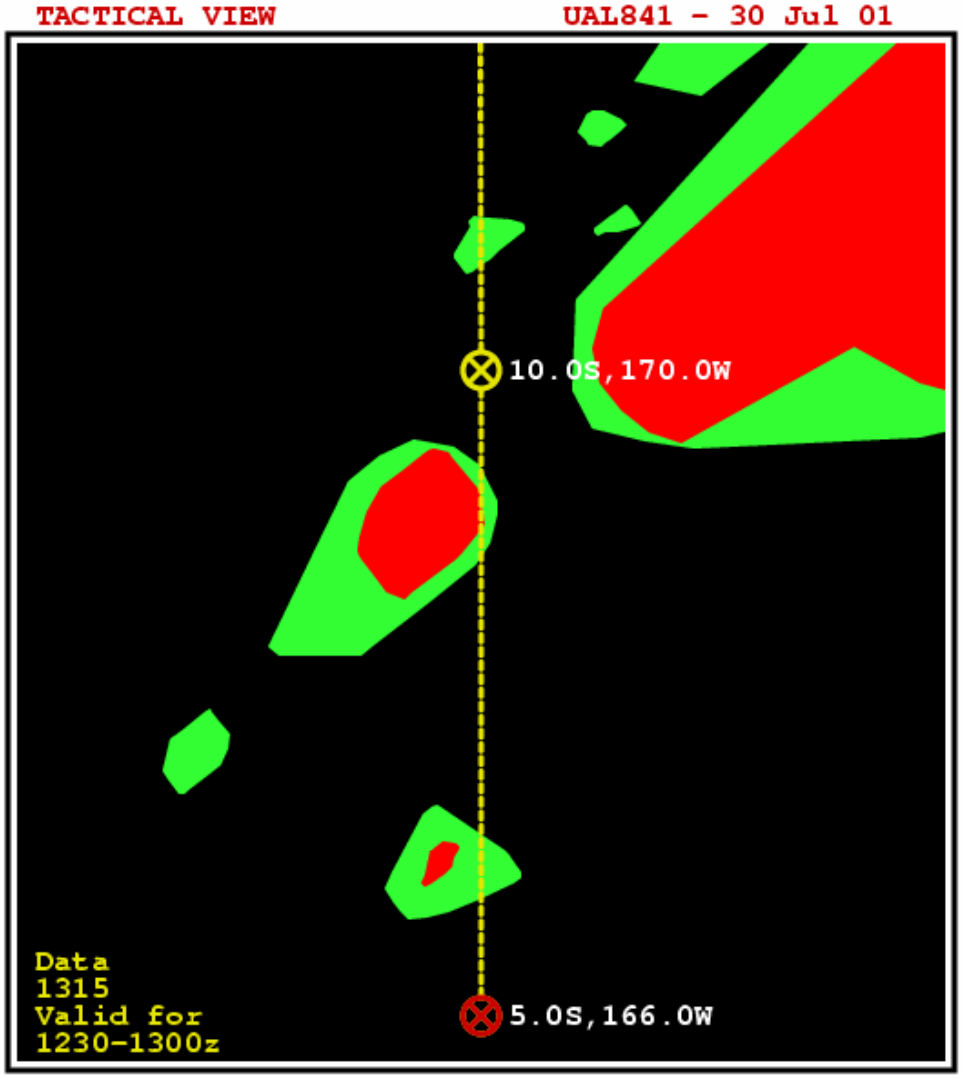
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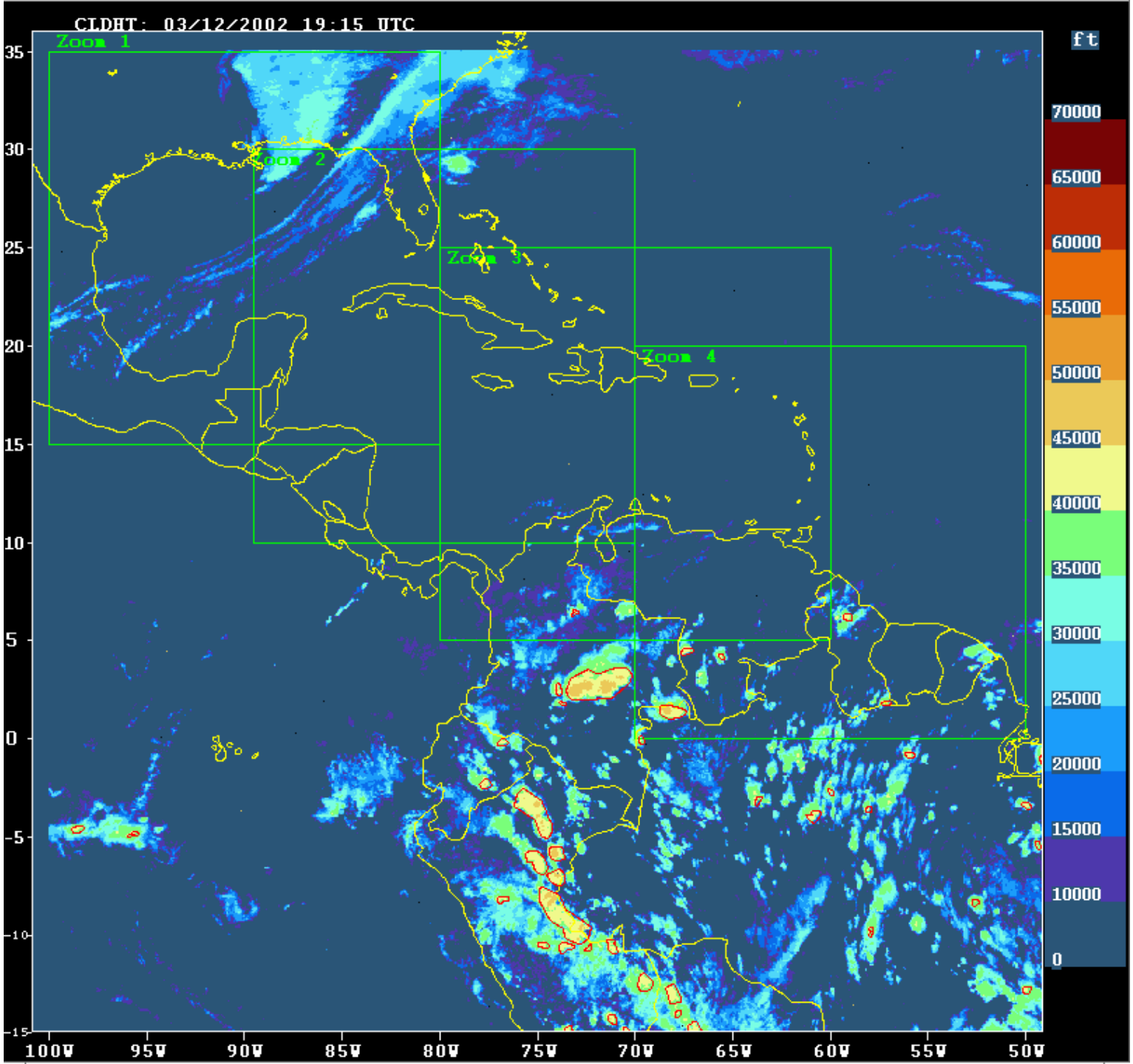
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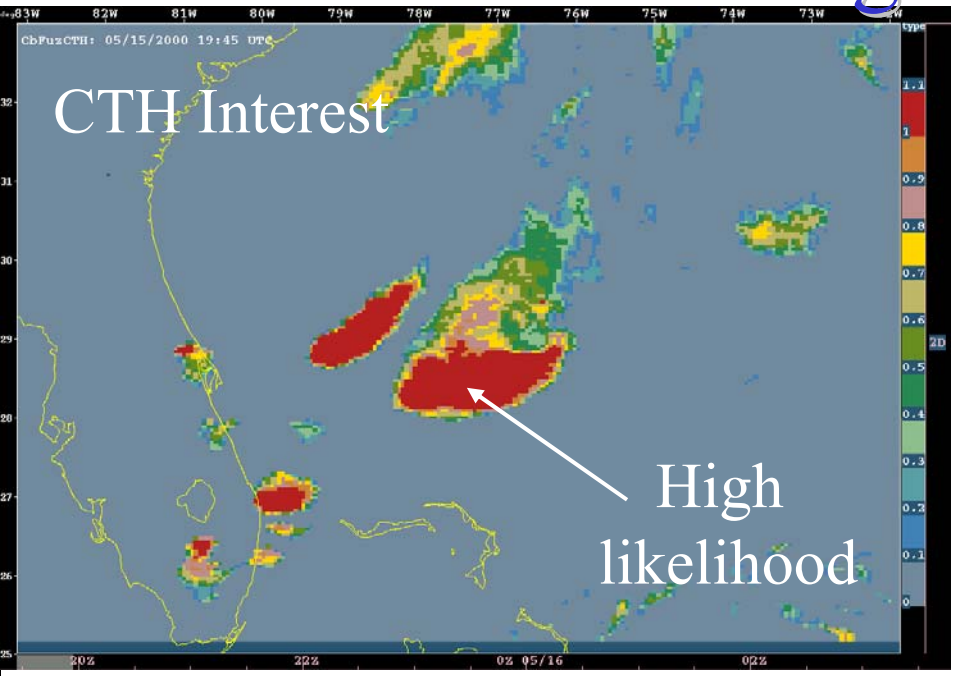
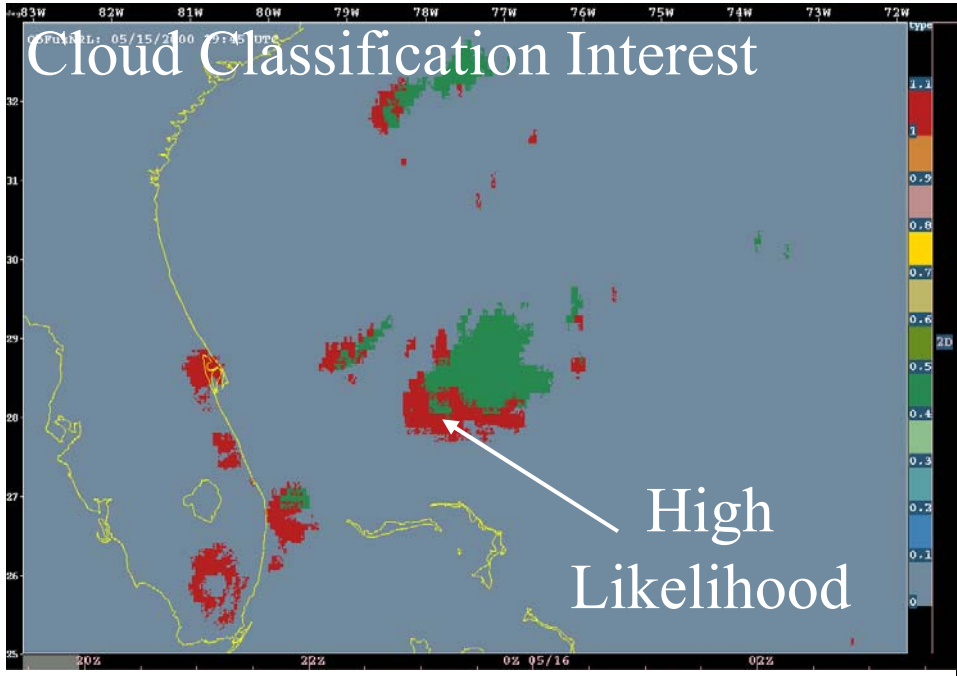
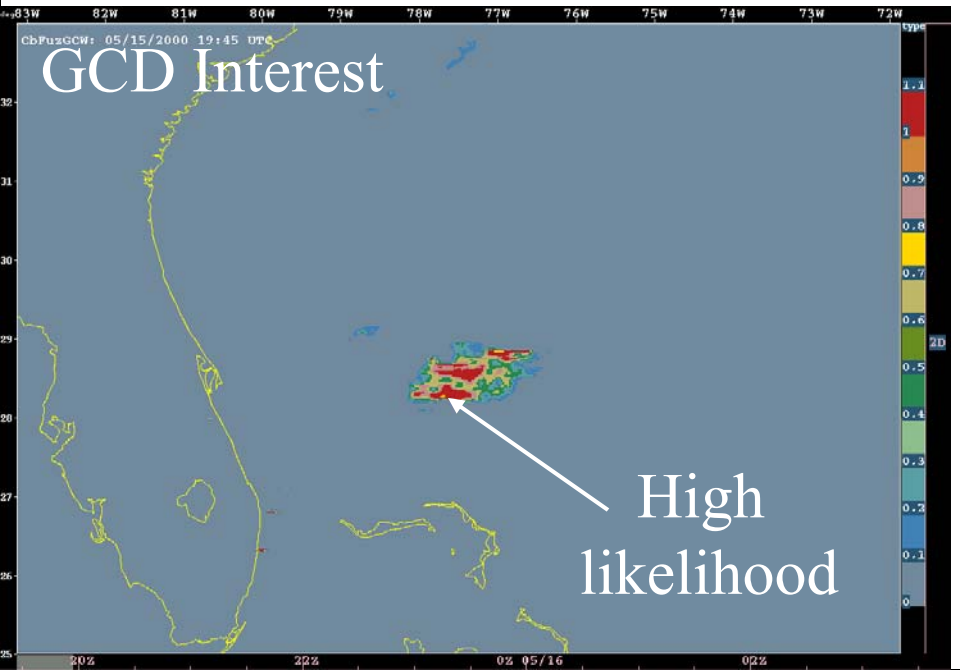
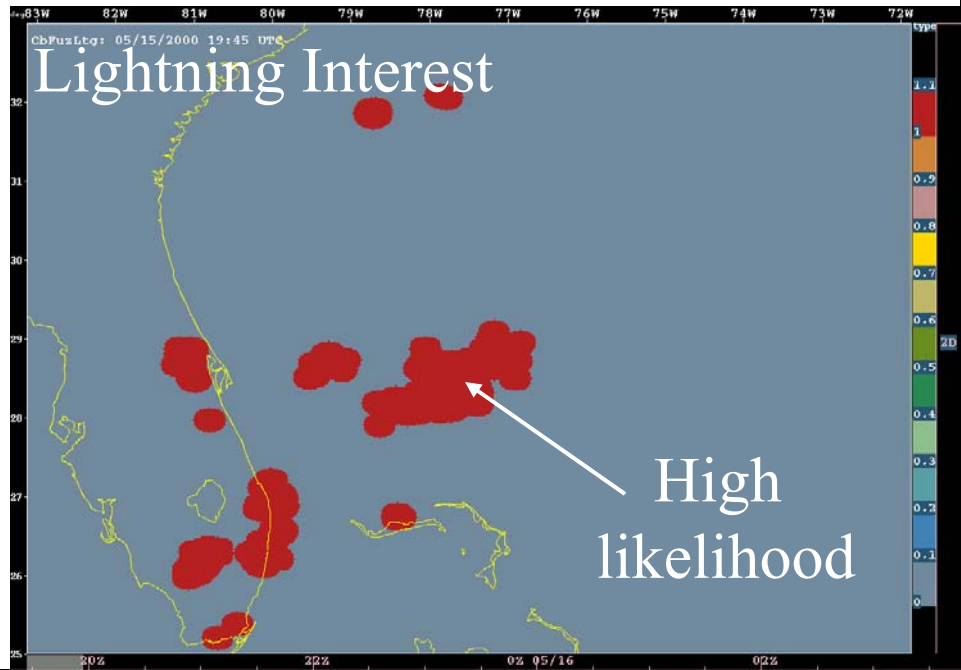
Convective Diagnosis Interest Fields









Dissemination of Improved Weather Information

NASA Aviation Weather INformation (AWIN) program

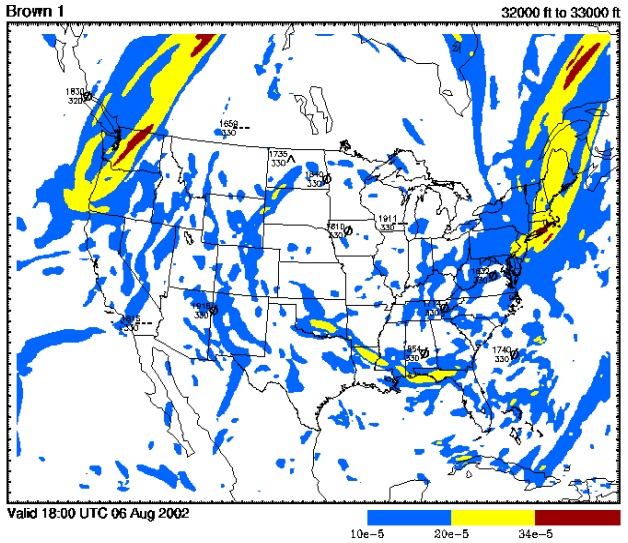
has accelerated the development of commercial cockpit systems employing new display and product technology

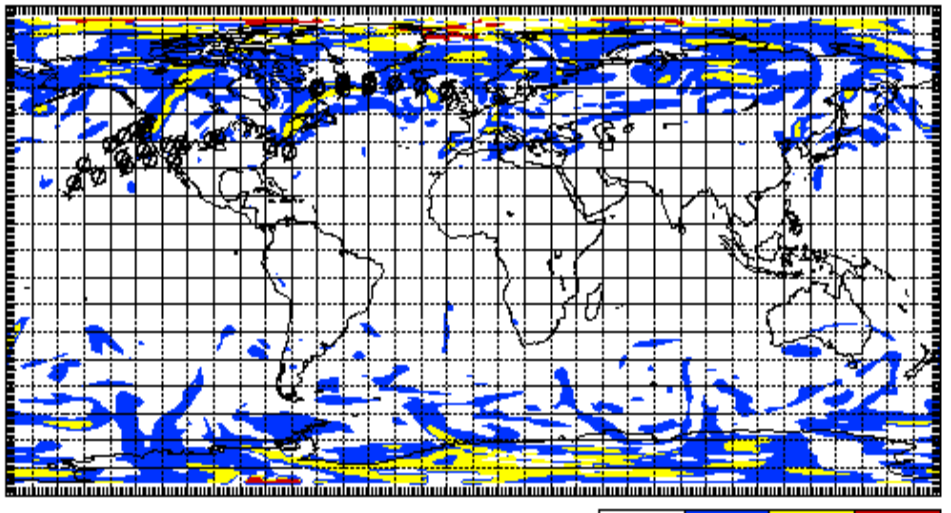
Global Integrated Turbulence Forecasting

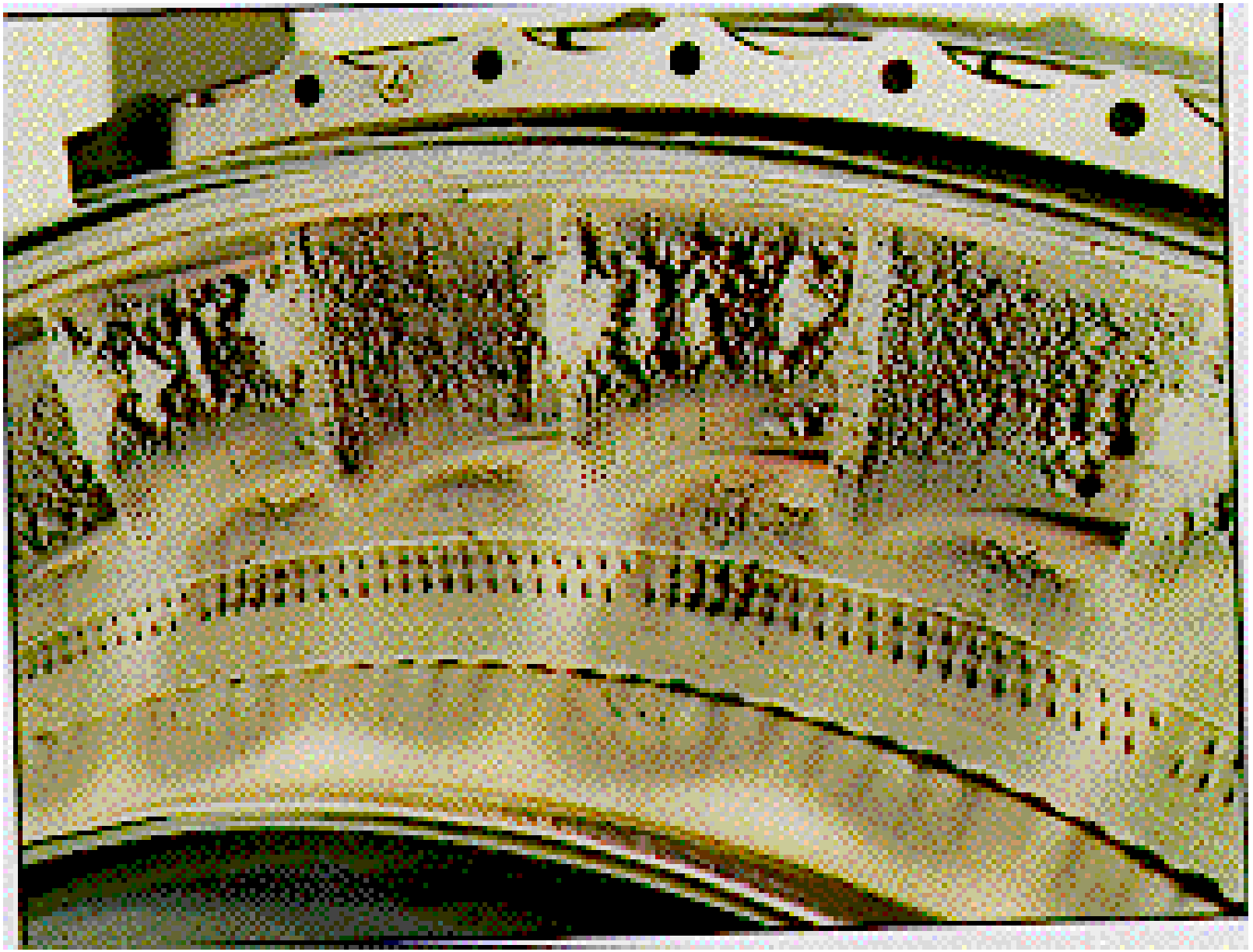
- Uses NOAA's AVN (now GFS) model
- Diagnoses and forecasts of CAT > 20,000 ft
- Prototype now available
- Example: Brown's index

  at 32,000 ft

  06 Aug 2002 18Z
  - Upper: derived from RUC20
  - Lower: derived from Global Forecasting System (GFS)







Heavy deposits of resolidified ash on nozzle guide,
Rolls-Royce RB211 (BA 747)

FAA Volcanic Ash User Needs Analysis Summary

- Need better integration of the agencies responsible for generating information on volcanic eruptions and ash clouds, with a collaborative approach that (a) provides all stakeholders the most current information and (b) permits all stakeholders to participate in updating information.
- Need a common database of text and graphic products that all users can access to facilitate collaborative decision-making.
- Stakeholders include airlines, air traffic management and control, weather providers, and the USGS.

Volcanic Ash User Needs Specifics

- Improved detection of volcanic eruptions globally, to include characterization of the initial ash cloud.
- Better characterization of the ash cloud as the event progresses:
  - Location, horizontal & vertical extent of hazard
  - Ash density and chemistry (hazard assessment)
  - Differentiate volcanic ash from meteorological cloud
- More frequent product updates.

Volcanic Ash User Needs Specifics

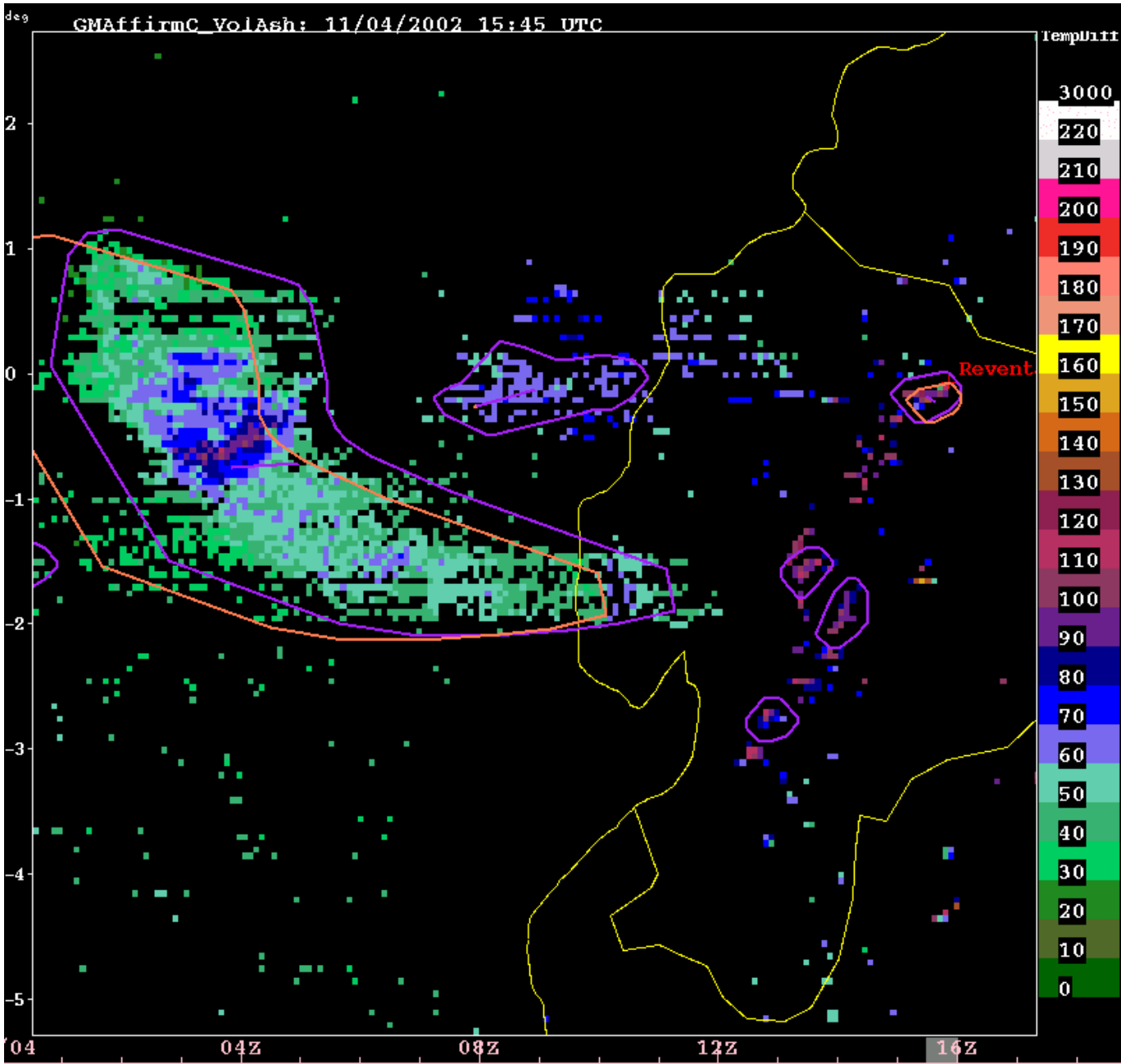
- Improved timeliness of updates (from observation or product generation to user access).
- Better forecasts:
  - Location, horizontal & vertical extent of hazard
  - Changes to ash density and chemistry
  - Longer valid time
  - Improved dissemination for flight planning
- Better training.
- Ready access to all information for all users (AOC's, flight crews, and ATC specialists)
- Higher resolution graphical products, including vertical cross-sections.


Reventador, Ecuador


Reventador
November 2002

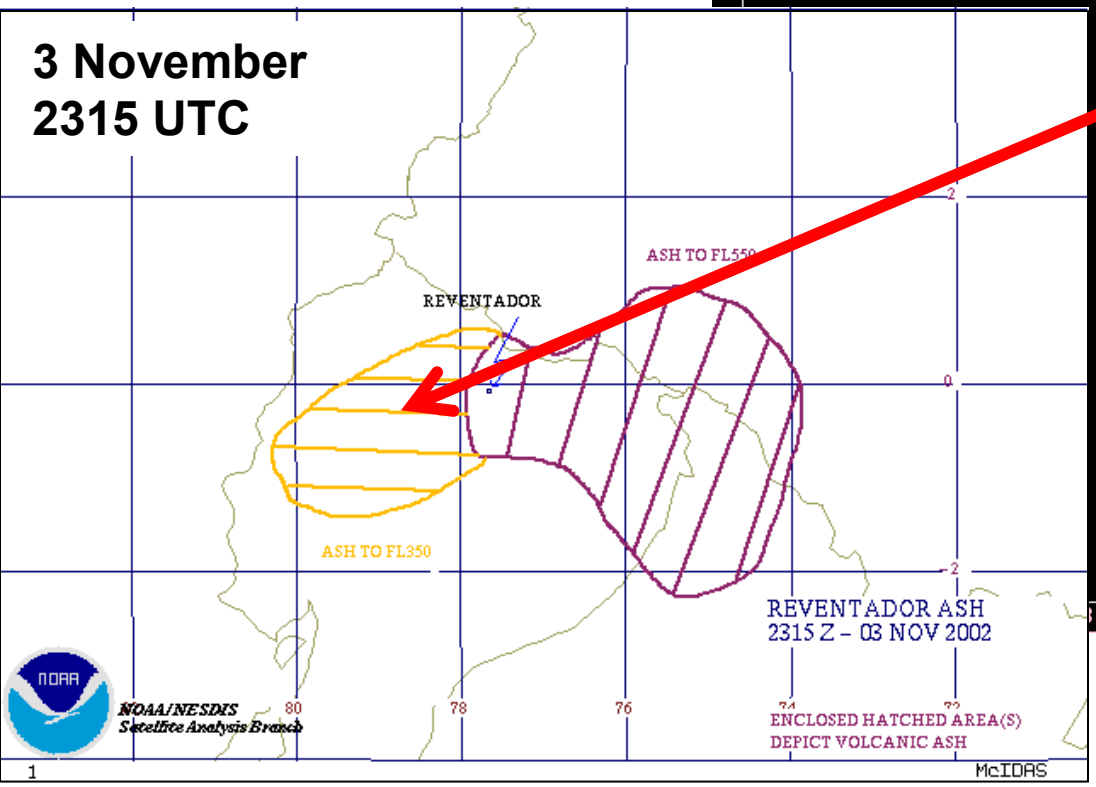
Reventador, Ecuador

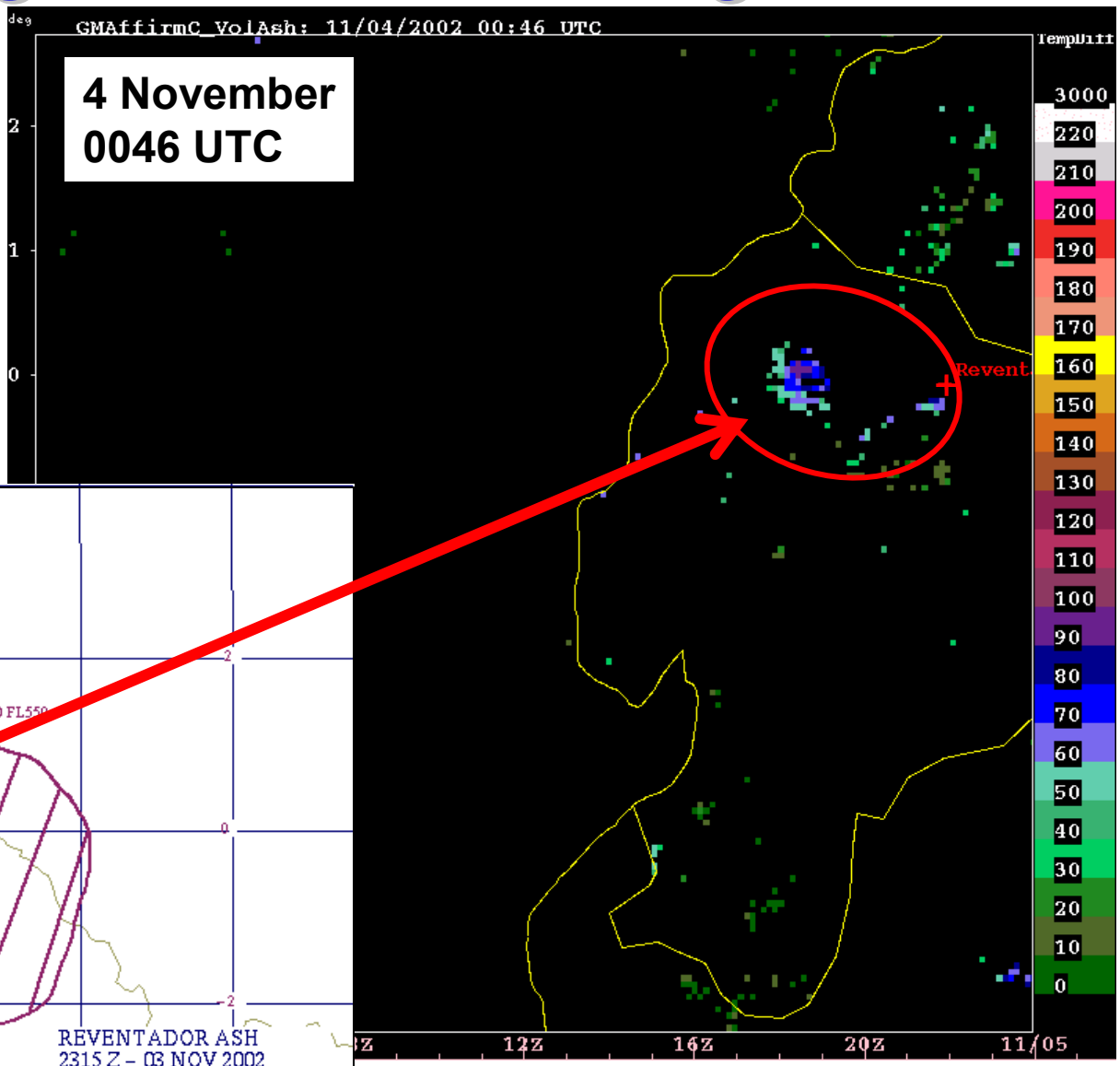
- 4 November 2002
  - 0046-1545 UTC
- Algorithm output at 30 min intervals
- Ash cloud is extrapolated
  - Purple = current position
  - Orange = 60 minute extrapolated position



Washington VAAC Warning

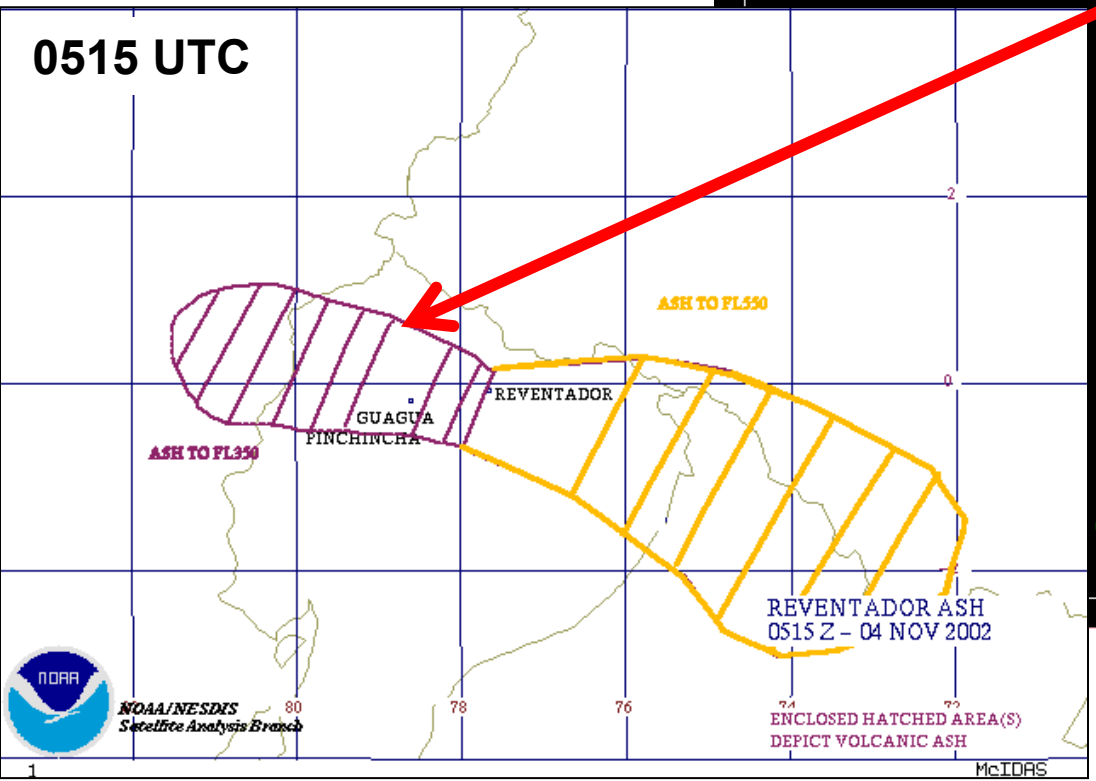
Reventador, Ecuador
3-4 November 2002

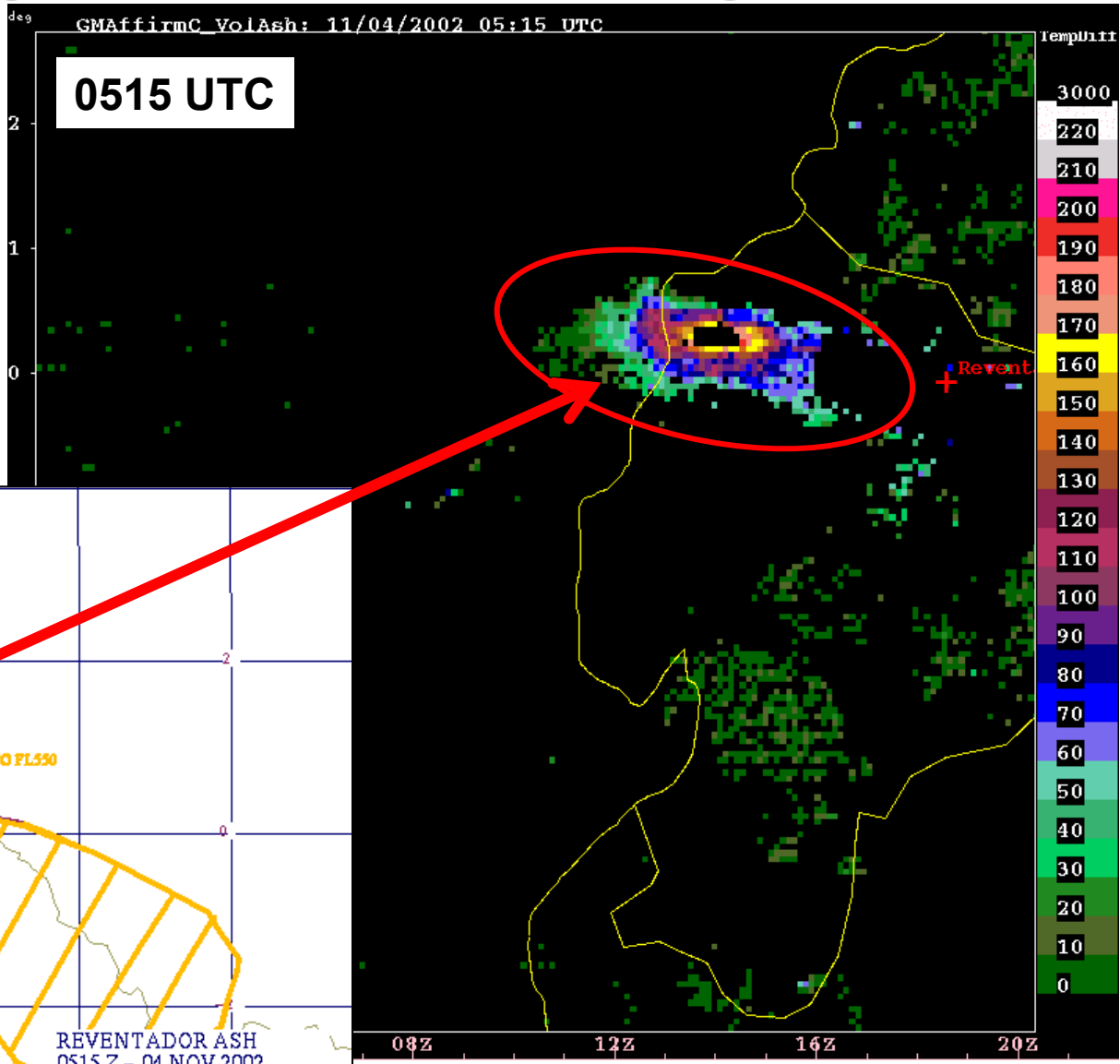


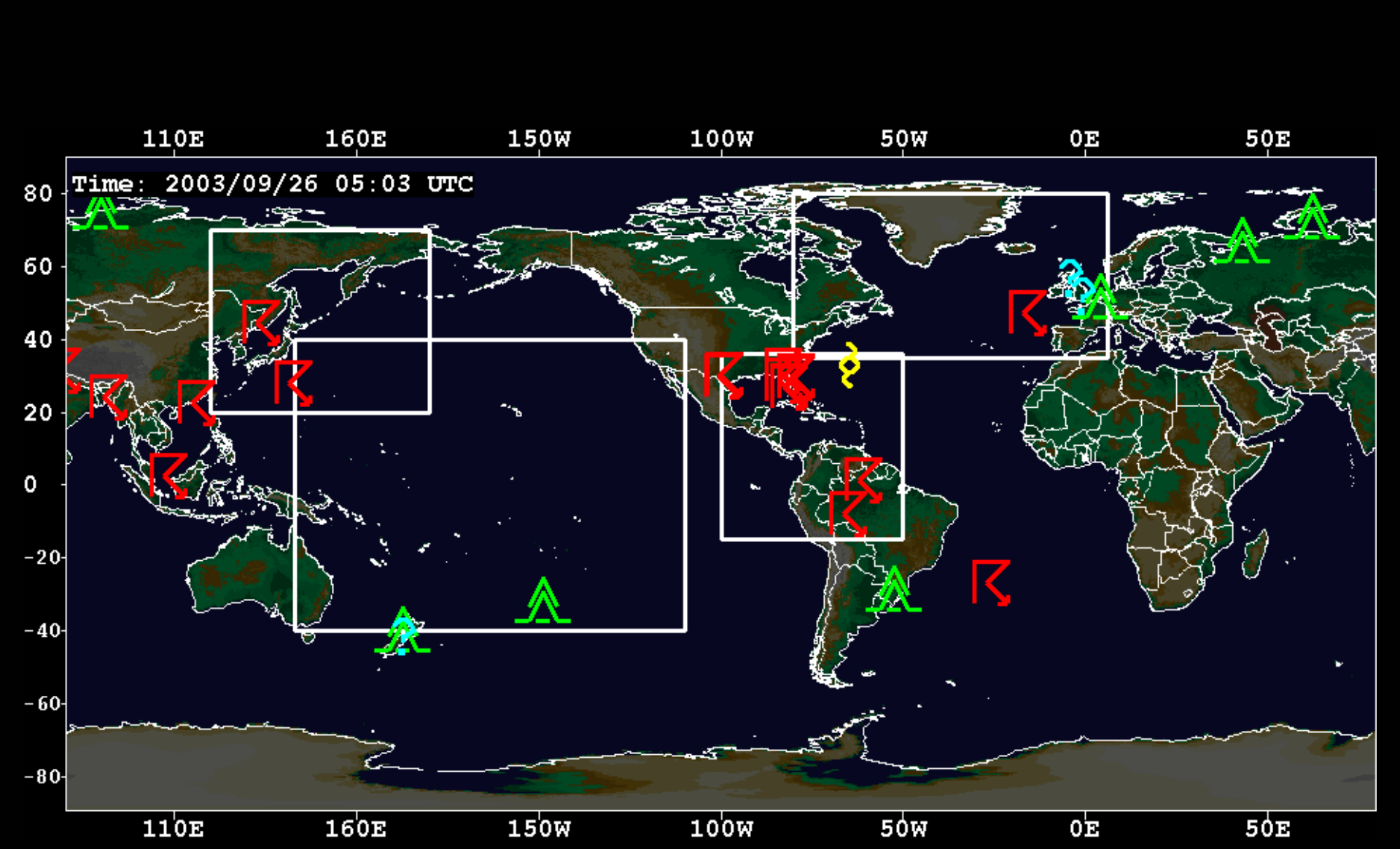


Washington VAAC Warning

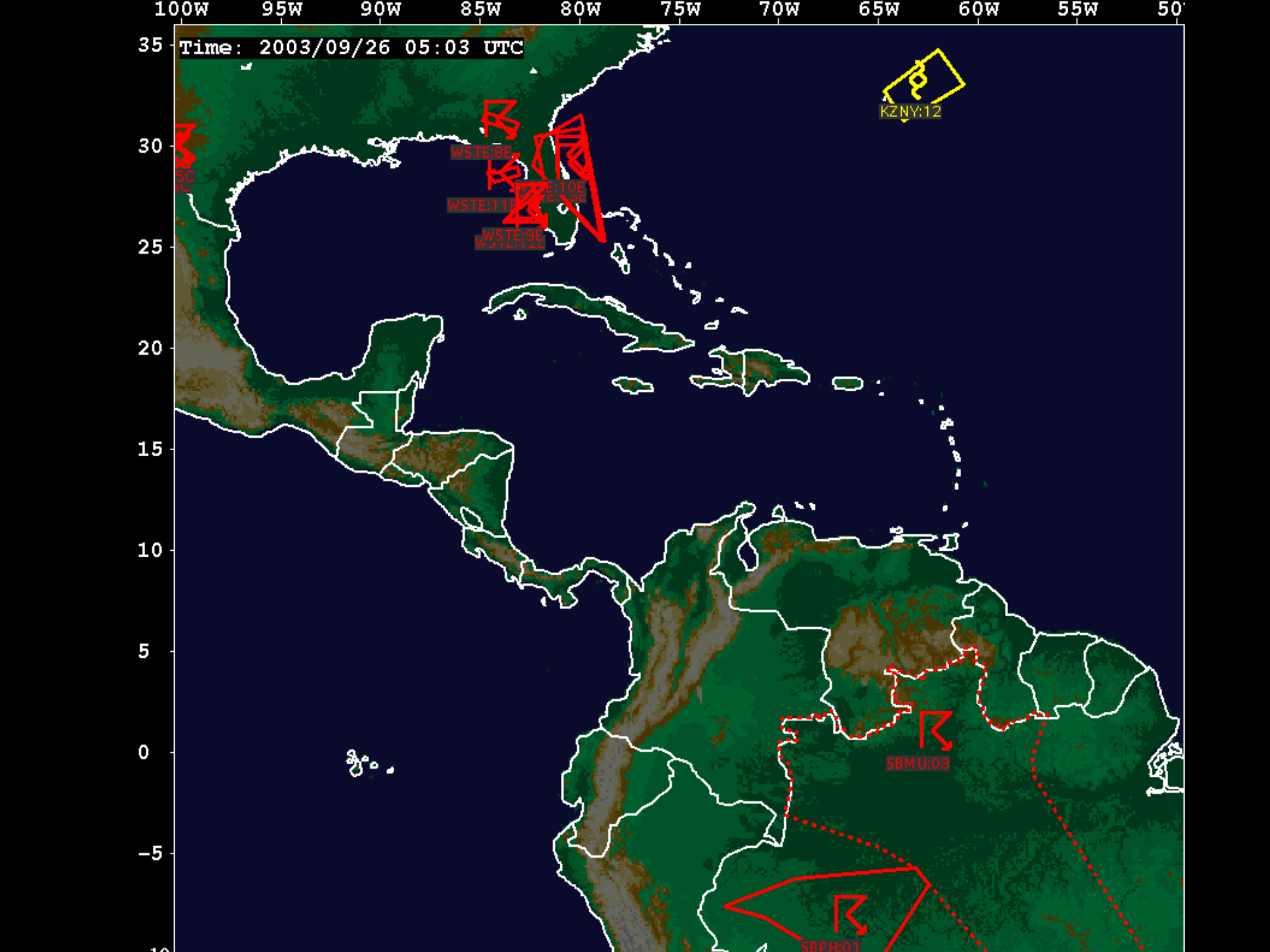
Reventador, Ecuador
4 November 2002







SIGMET Decoder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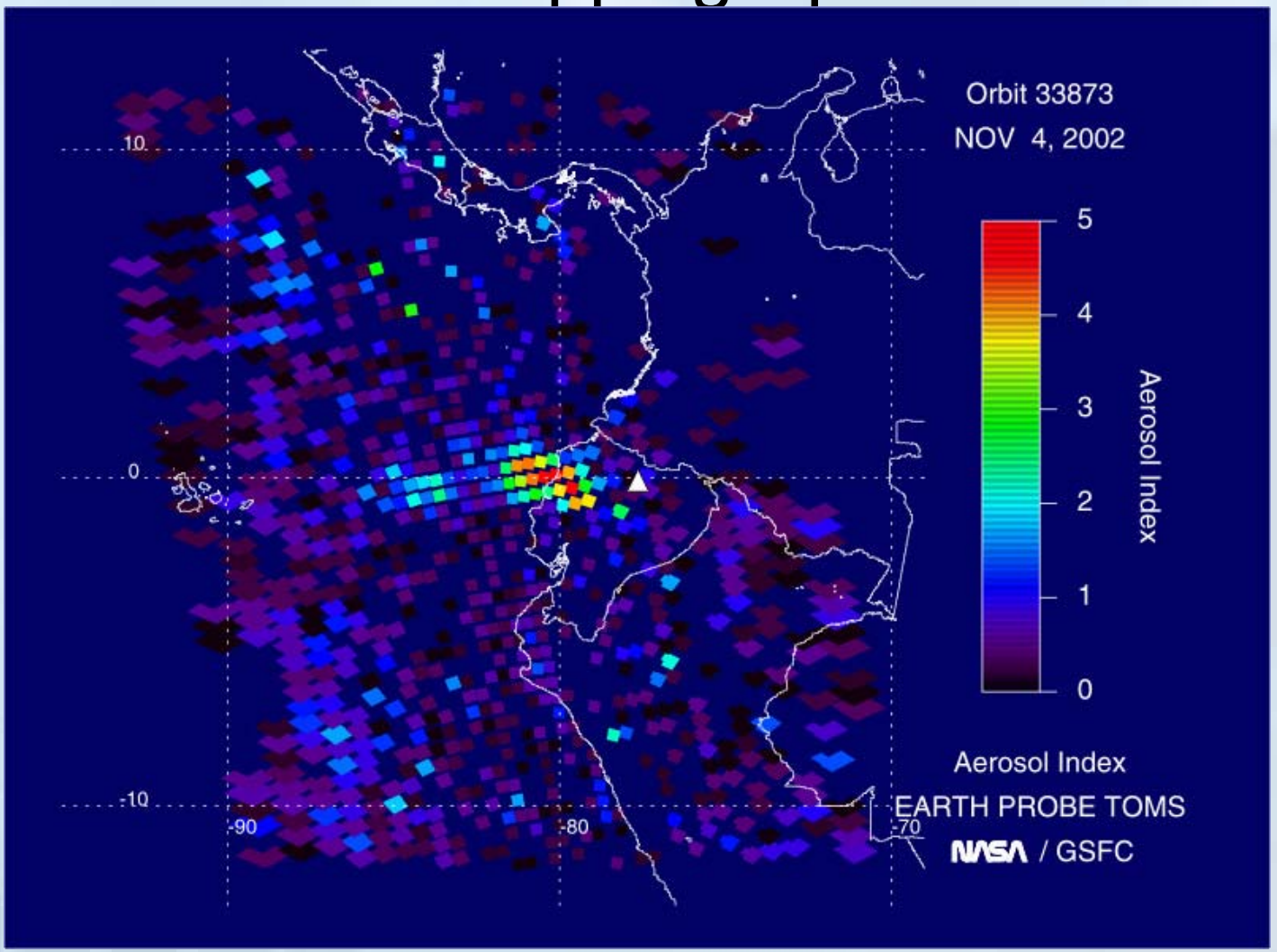
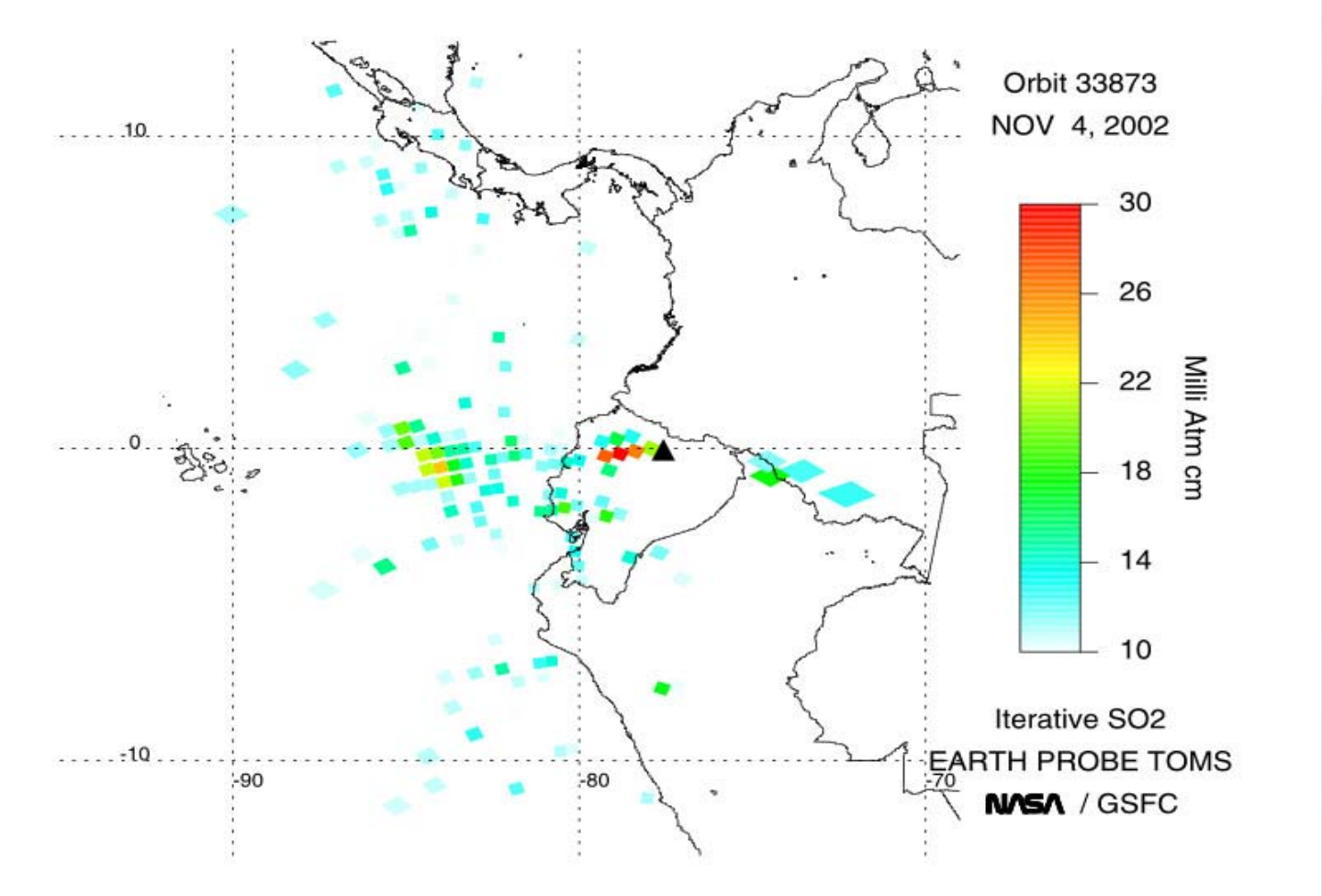
Reventador Ash Cloud
Total Ozone Mapping Spectrometer



Reventador SO2



Air Traffic Management

- Traffic flow management (TFM)
- Airspace management (ASM)
- Air traffic control (ATC)

All elements of ATM are just as important for some oceanic regions as for CONUS, such as the GOMEX and NAT regions, but *without* the benefit of positive radar contact. The system compensates by increasing horizontal and vertical separation. RVSM/RHSM *will impact* ATM when hazardous weather is present.

ATM Challenges for Oceanic Regions

NCAR

- Weather has a large impact on effective ATM—nothing different for oceanic regions
- Oceanic ATM will require different DSS rules and tools than CONUS ATM. Why?
  - Lack of positive radar contact and communications
  - Differing vertical and horizontal separation standards by region and aircraft equipage
  - Organized track systems (HNL-CONUS, NOPAC, NAT) remove rerouting flexibility. Add to this RVSM and RHSM.
  - Differing traffic patterns, flow density
  - Differing weather hazard thresholds

ATM Challenges for Oceanic Regions

- Shared situational awareness between traffic managers and flight crews. Timely dissemination and display to both.
- DSS must allow for tactical avoidance. It may not be practical to reroute strategically within the organized track system
- Enhance positive positioning (FANS) and positive communication (data link)
- Enhance precision and resolution of weather information
- DSS (in current paradigm) should include a human in the loop
- Probabilistic forecasts?
- Operational concept for oceanic ATM/DSS

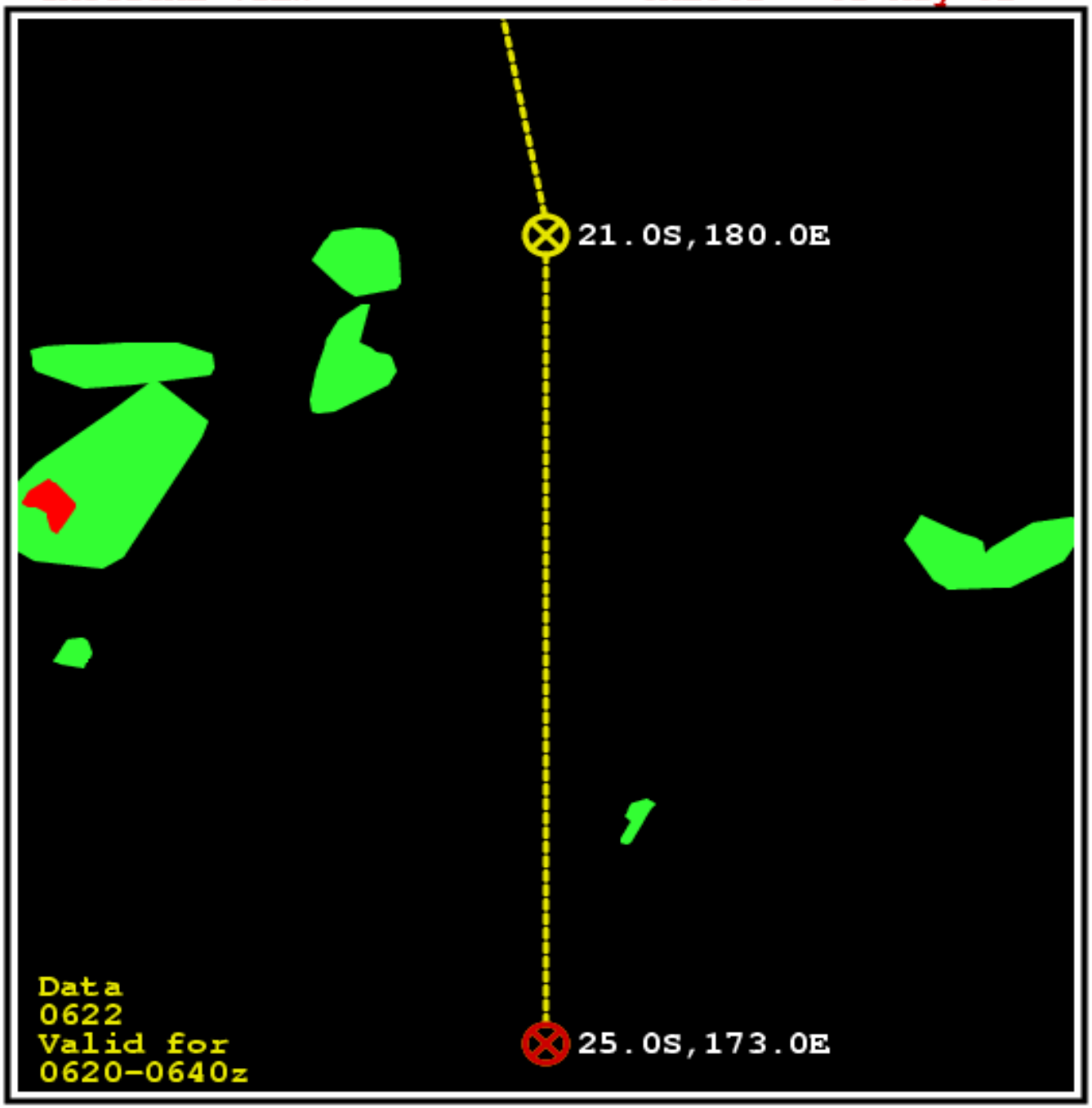
ATM Challenges for Oceanic Regions Summary

- Capacity on oceanic routes often a serious constraint when hazardous weather is present, particularly CONUS-HNL, NAT, and GOMEX regions
  - Integration of high-resolution weather information into automated ATM systems is essential
  - Requires an oceanic ATM operational concept that includes weather information
  - Also requires close coordination with on-going oceanic modernization programs—FAA's Oceanic IPT and ATOP programs
  - Rapid prototyping of automated systems, new paradigms, and human factors studies might be highly desirable or required
  - Real-time flight crew updates are essential

Oceanic Weather Web Site:
http://www.rap.ucar.edu/projects/owpdt

Questions?

TACTICAL VIEW UAL862 - 01 May 02



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